The ~~Design~~ of a Recording Apparatus for Torsion Tests.

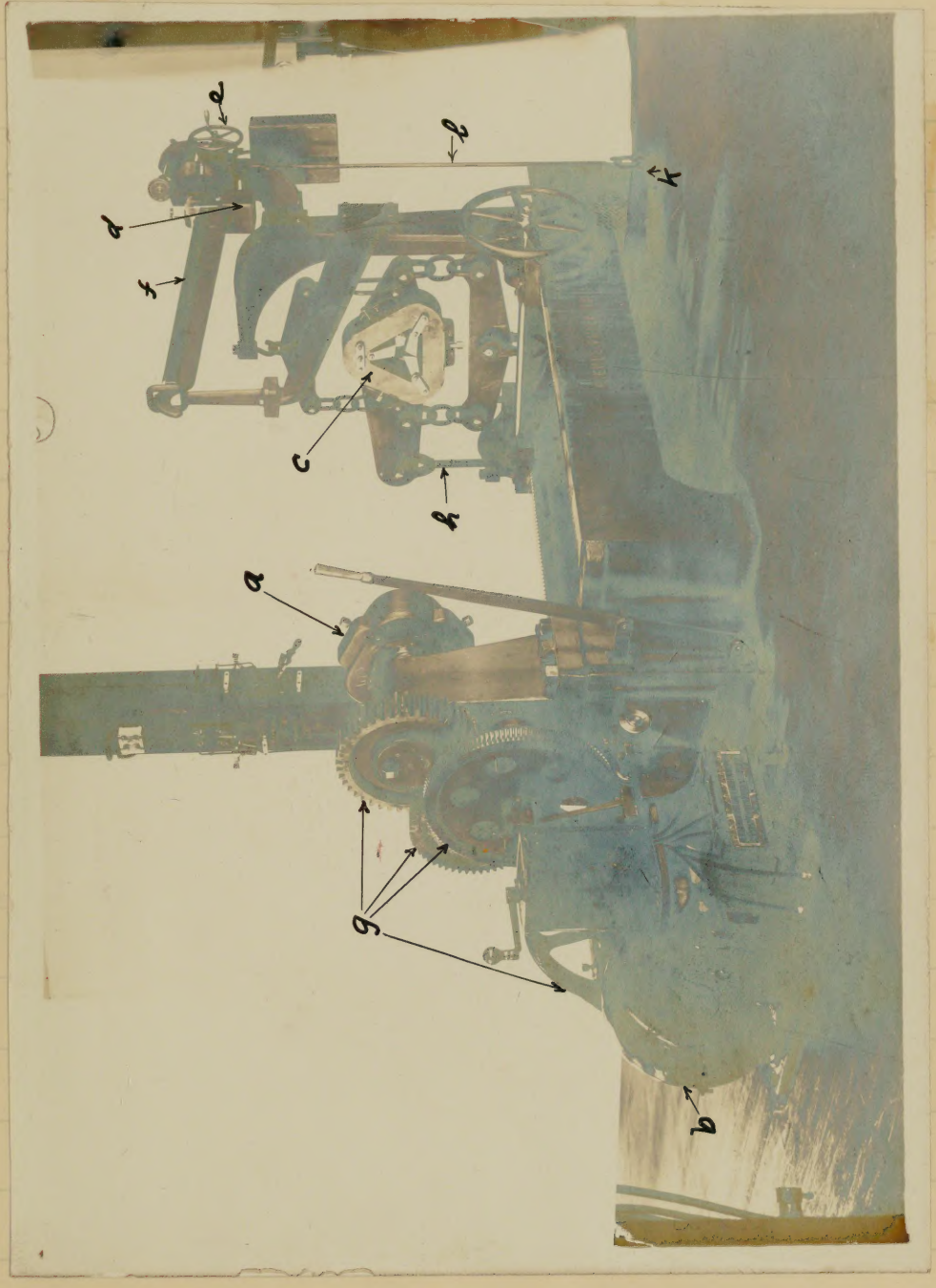
Beener

The chief object in view in this work was to design an apparatus to automatically plot curves of the torque and the angle of torsion of a specimen tested for torsion. The ordinates of this curve are to represent the torque in pound-inches and the abscissas to represent the angle of torsion of the specimen between two fixed points on the specimen tested.

Before beginning the description of the Autographic Apparatus it will not be out of order to say a few words in regard to the Torsion Machine for which the apparatus was designed.

The Torsion Machine is a 60,000 inch pound machine made by the Riehlé Bros. Testing Machine Co., of Philadelphia, Pa. A photograph of the machine is given on page (2).

It consists essentially of two parts;


a
b
c
d
e
f
g
h
x

the twisting mechanism and a weighing device. The mechanism for producing the torsion of a moveable head (a). The moveable head is turned by means of the motor (b). A low speed of this head is obtained by means of a reduction through a system of worm and spur gearing (g). This head has three jaws which serve to hold one end of the specimen to be tested. The other end is held by a similar head (c). This head (c) serves as one of the lever arms of the weighing system, the force applied to the specimen is transmitted through the levers and connecting links (h), (k), (l), to the beam (f). A poise (d) moving over this graduated beam serves to balance the force exerted on the link (h). This force is due to the twisting movement or torque exerted on the specimen. The lengths of the levers and the weight of the poise, etc. are so arranged that one inch on the scale beam represents

2000 inch-pound twisting movement.

The weight or poise (d) may be moved along the beam by means of a hand wheel (e). This hand wheel through a system of spur and level gearing turns a rod (f) containing a spiral groove or coarse thread. The poise forms a nut to this rod (f), and the turning of the rod causes the poise to move back or forth over the scale beam. With this and some other information, concerning the size of gears, etc., of the arrangement for moving the poise along the beam it was desired to design an apparatus which should automatically plot a curve between the twisting movement and the angle of torsion of the specimen tested.

It may be noted at this point that neither the fixed nor the moveable head hold the specimen without slip. The jaws dig into the specimen. This slip in ordinary spec-

imens amounts to considerably more than the true angle of torsion within the elastic limit. For this reason the angular motion of the moveable head could not be relied upon to give the angle of torsion of the specimen.

In order to obviate this error two pulleys are attached to the specimen itself and by measuring the difference in angular movement between the two pulleys we can obtain the angle of torsion between the two points on the specimen at which the pulleys are attached. To obtain the difference of angular movement in such a manner as to record it automatically was a matter causing some little perplexity.

In this apparatus,-an assembled drawing of which is shown on plate I) of the appendix,-the diagram or curve of twisting movement and angle of torsion is drawn on a

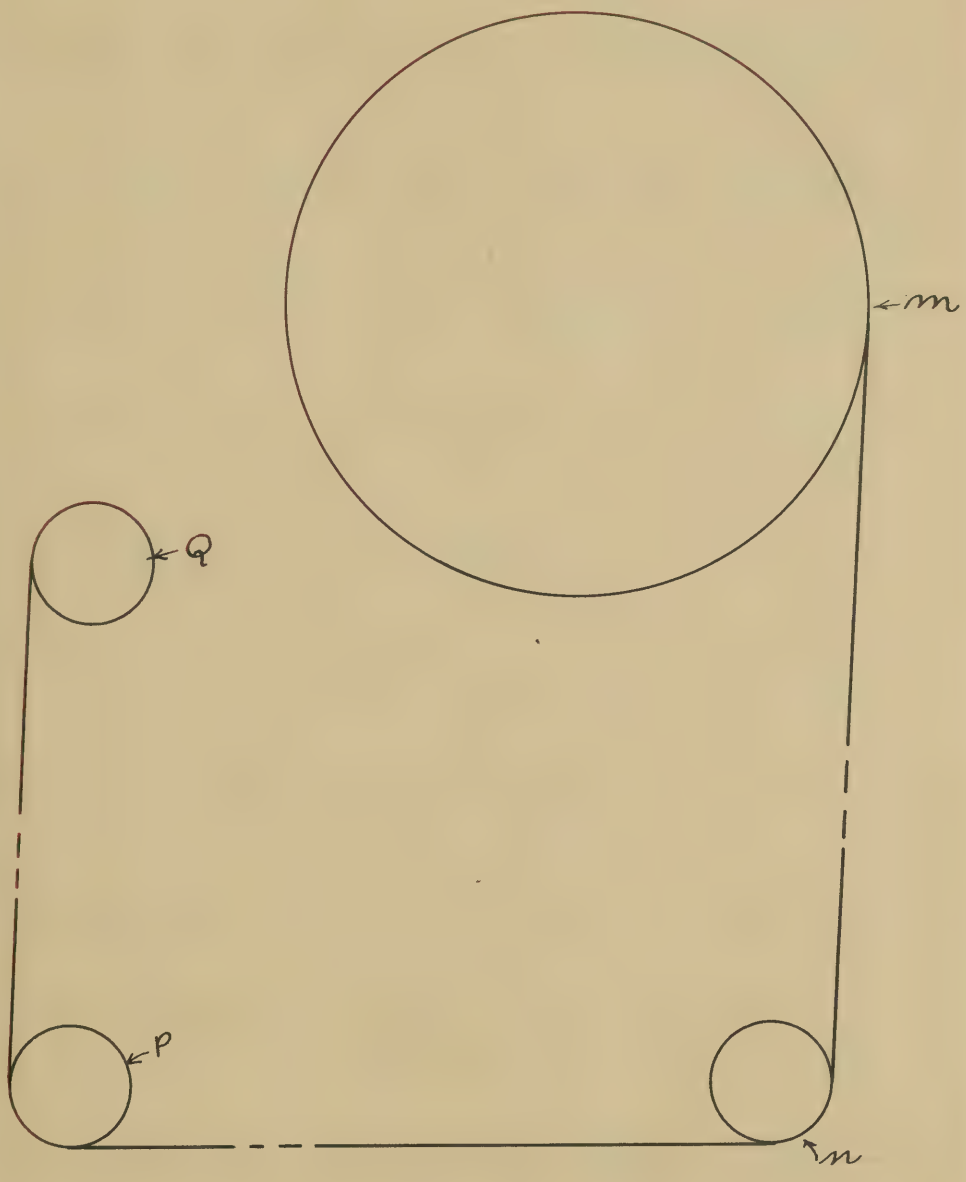
paper which is attached to the cylinder or drum (A) by means of four double clips (B). The pencil arrangement shown at (s) in the figure serves to trace the curve, either by its own motion of the drum or both. The relative motion of the pencil around the drum is regulated by the difference in the angular motion of the two pulleys on the specimen. The motion of the pencil along the drum is produced by the motion of the hand wheel (e) in the photograph on page (2).

The difference in the angles of torsion of the two pulleys is accomplished in the following manner. One end of the cord* is attached to one of the pulleys on the specimen. It passes to a pulley fastened to the floor directly below the wheel on the specimen, then over the pulley (P) on the base of

*must be a cord which stretches very little on applying a load.

the instrument; and finally the cord passes once around and fastens to the pulley (Q). This pulley is fixed to the spider (R) which carries the drum (A). By the arrangement the drum is revolved when the specimen turns at the point where the pulley (m) is attached to it. The other pulley on the drum is arranged in a similar manner. The cord passing over a pulley on the floor, see page ( ); and plate I and to the pulley (P) on the base of the instrument thence up to the pulley (Q). After passing once around the pulley (Q) it is fastened to it. By this arrangement the arms carrying the pencil arrangement.

The cords passing over the pulleys are wound in the same direction when the specimen turns. The cords on the pulleys (Q) and (Q) are unwound in the same direction when the test specimen turns. Thus by the pencil moving in the same direction as the paper, the


m
Q
P
n

relative motion of the pencil and paper will give the difference in the angles torsion of the two points on the test specimen. In order to keep the cords taut during the test a spiral spring (N) is attached to the spider (R) which is attached to the drum. The other end of the spring is attached to the pin (L) in the shaft (K) to which the arms (M and M) are attached.

The movement of torsion is plotted, as already stated, by movement of the pencil arrangement (s) along the rods FF. This motion is obtained from the hand wheel (e), (see photo. page (2)) of the Torsion Machine. As this Wheel makes 3/4 of a revolution for each 1000 inch pounds on the beam its motion must be reduced. This reduction is affected as follows;- A cord is wound several times around the hub of the hand wheel (e). The number of turns of

cord on this hub depends on the torque which is desired to measure. At the one end of these coils the cord is fastened to a pin in the hub of the wheel and then the two ends are dropped to the pulley (HH_1) which are placed directly below the hub on (e). The pulleys (HH_1) are made in one piece.

The one end of the cord makes several turns around the groove (H) and the end fastens to it. The other end of the cord is wound in the opposite direction around the groove (H_1) and is fastened to it. The shaft (E) to which the pulley (HH_1) is attached can thus be rotated in either direction by movement of hand wheel (e). To this same shaft (E) is attached the pulley (GG_1) with two grooves. Over the groove (G_1) is wound a cord with one end attached to it. The other end passes up over the pulley (E_1) and through the centre of the shaft to pulley

(D$_1$) then to pulley (C$_1$) and to the pencil arrangement (s). A cord is attached in a similar manner to the pulley (G) and is passed over the pulleys (J), (I), (E$_2$), (D) and (C) to the other end of the pencil arrangement. By this reducing arrangement the movement is reduced so that one inch movement along the drum indicates an increment of 2000 inch-pounds twisting movement.

The bearings for the shaft (K) consists of two centres which fit into the counter-sunk holes in the end of the shaft. The shaft (E) has similar bearing. These bearings may be adjusted by loosening the lock nuts and moving the centre threaded into the stands. In order to put the paper into position under the clips it is necessary to have some arrangement for raising the clips. Since there are four clips to hold each end of the paper it would be impossible for one

to raise all the clips at one time without some mechanism. Four cams, under as many clips, are attached to a rod (W). The rod is turned through a small angle by the arm (V). A bearing (Y) alongside of each clip (B) serves as a guide for the rod. A similar rod (W_1) with cams and bearings is arranged under to raise the other four clips.

The Pencil Arrangement.

The pencil is held against the paper by means of the spring (a) (Plate I) pressing upon the disc (k) attached to the tube (e). In the end of this tube is a small lead holder or pencil (h). A small disc (m) at the end of the tube (f) serves as a guide for this pencil. The cap (b) which is threaded on the tube (f) serves as a second guide for the tube carrying the pencil point. A small post at (c) serves as a stop upon which the pin (g) rests when it is desired to hold the

RECORDING APPARATUS FOR TORSION TESTS.

F.B. Full Size June 1904.

4 of these equally Spaced along Drum.

32 Coils ¼" Spring Wire.

2 Cords To Hub on Hand Wheel.

End of Arm M.

Rods F.F.

Mahogany Base. 34½" x 7"

34½"

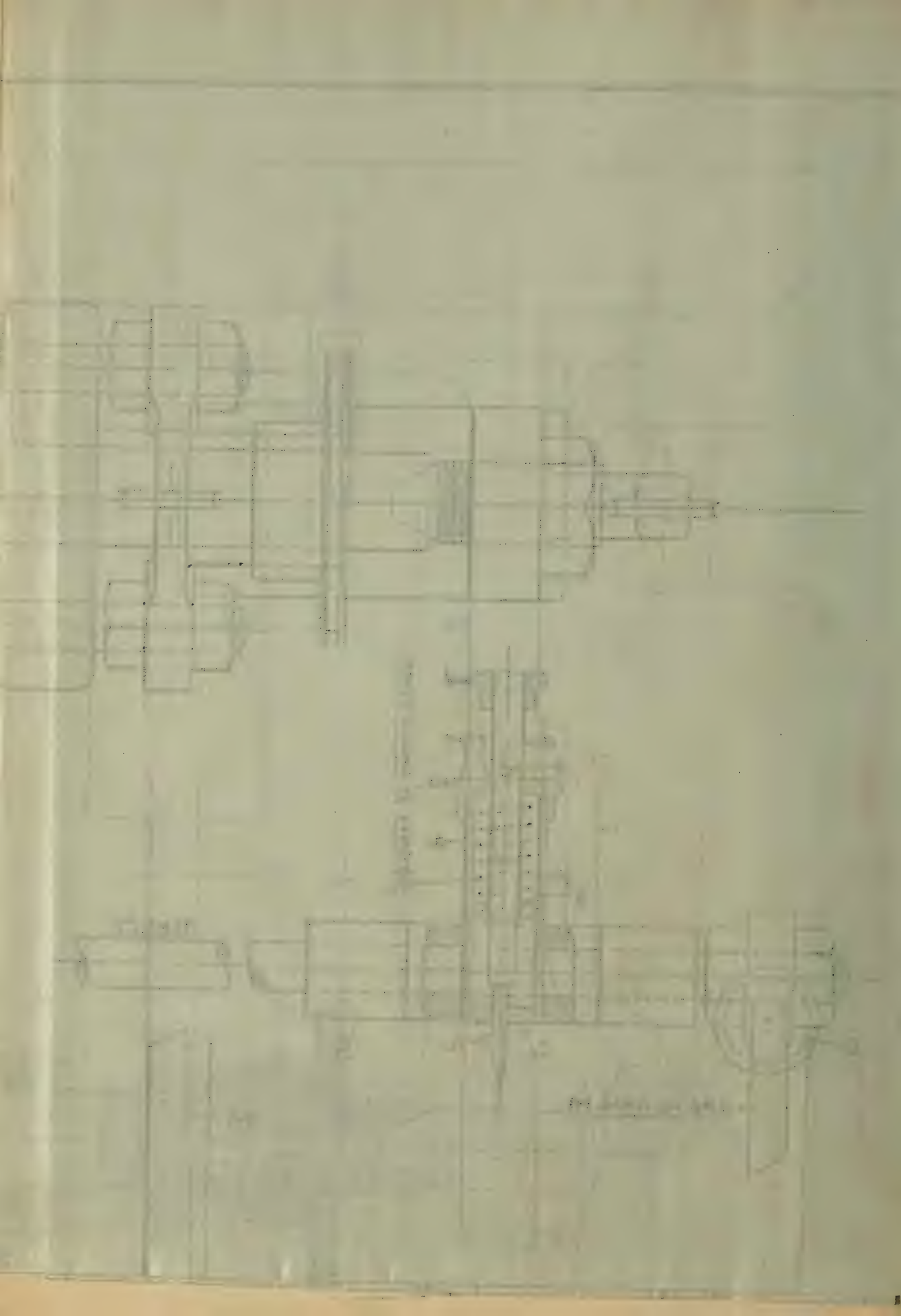
19"

21⅜"

2"

1⅛"

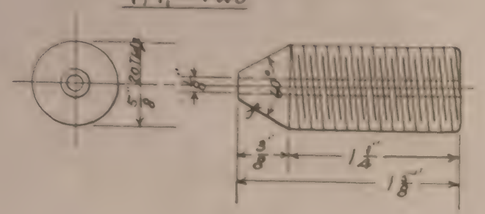
⅝"



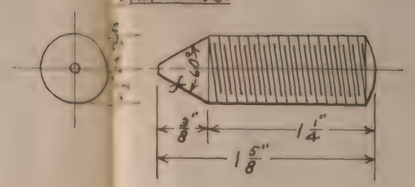
[illegible] end of the paper.

Details of the various parts of the apparatus are given on Plates II, III, IV, V and VI. The letters on the details correspond to the letters on the assembled drawing.

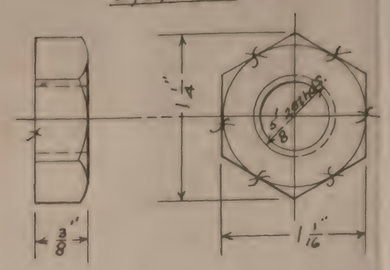
T, T, - Two



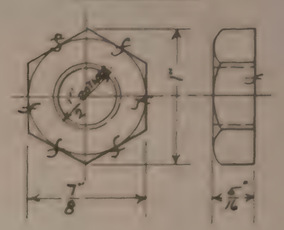
Y, Y, - Two.



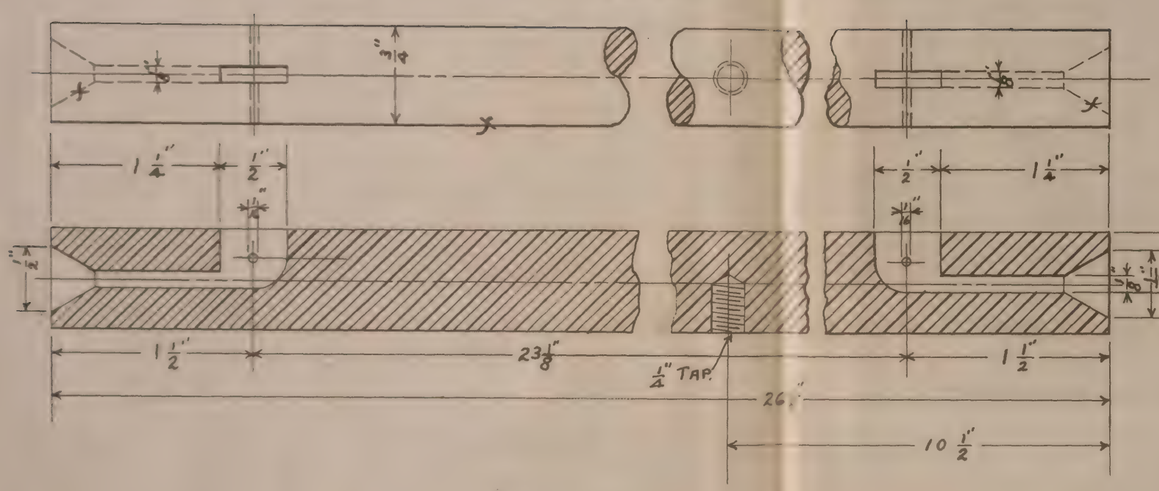
Z, Z, - Two.



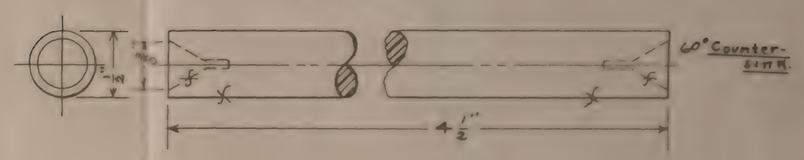
n - n, - Two.



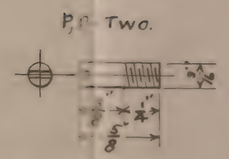
K - ONE.



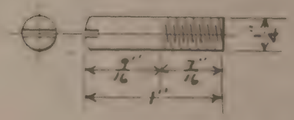
E - ONE.



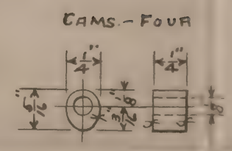
P, P. Two.



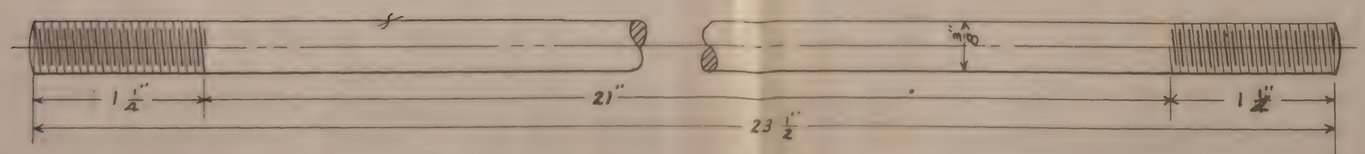
L - ONE.



CAMS. - FOUR

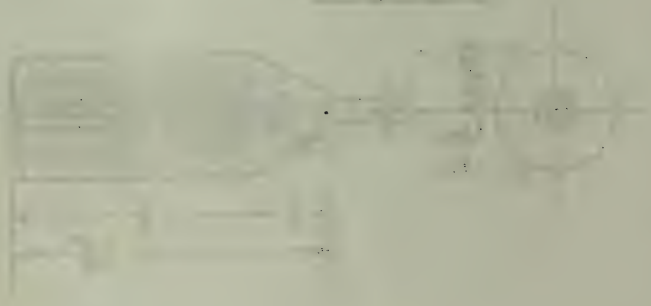


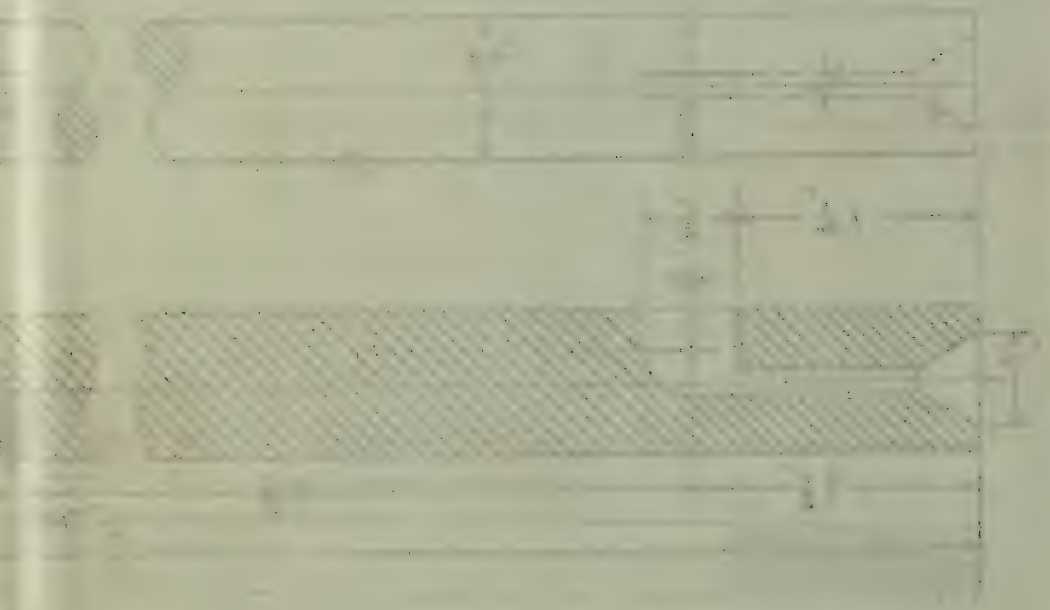
E, F, - Two.



DETAILS.
RECORDING APPARATUS.
FOR
TORSION TESTS.

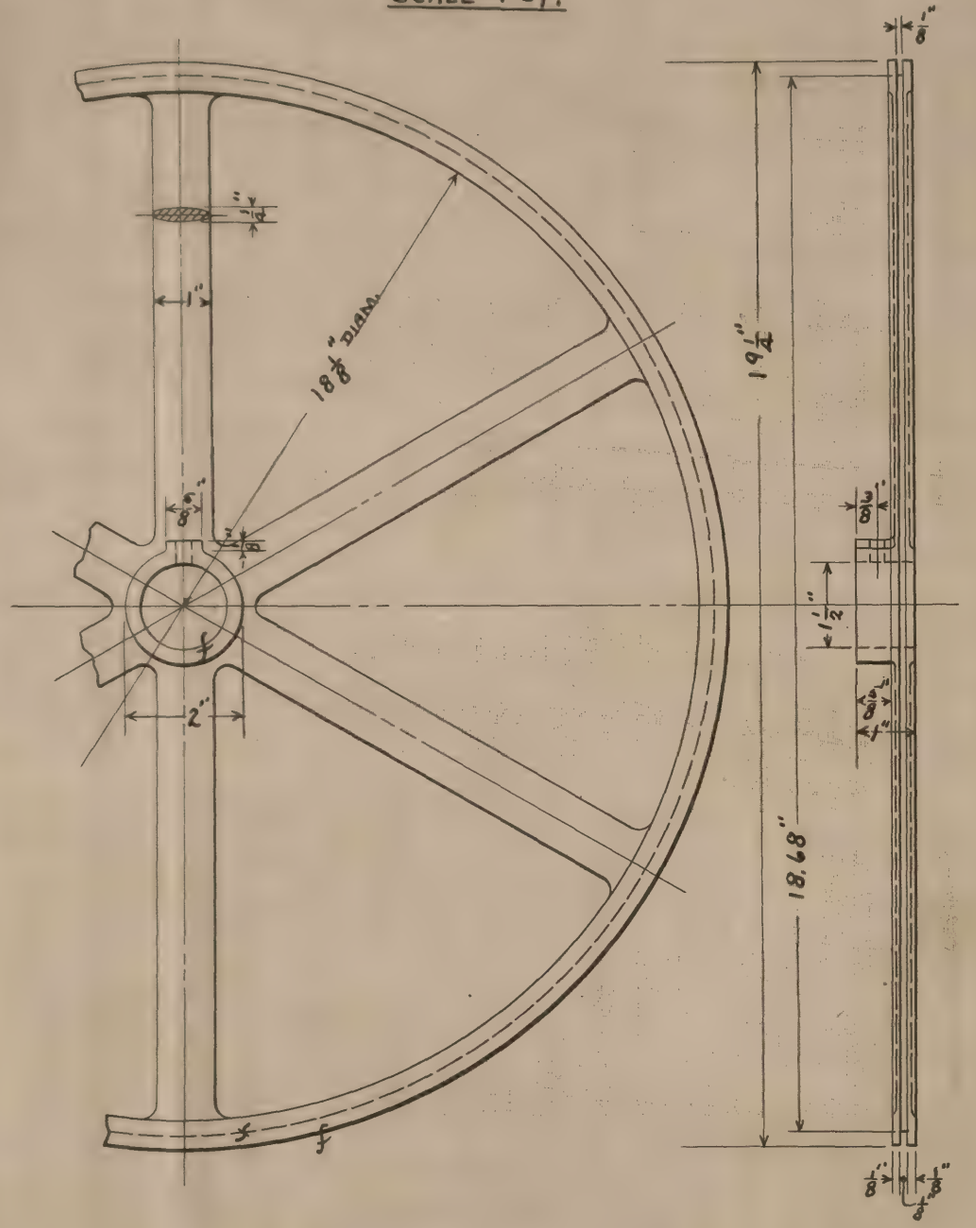
F.B. COLD ROLLED STEEL. JUNE, 1904.
Full Size.



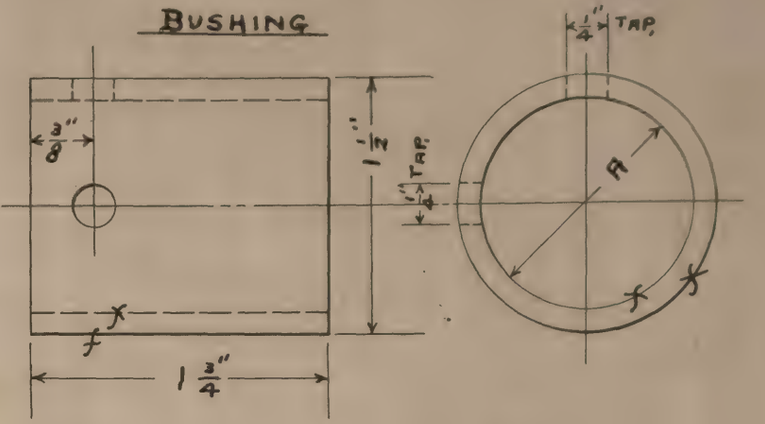


2-PULLEYS- FOR SPECIMEN.

SCALE 4"=1'.



BUSHING

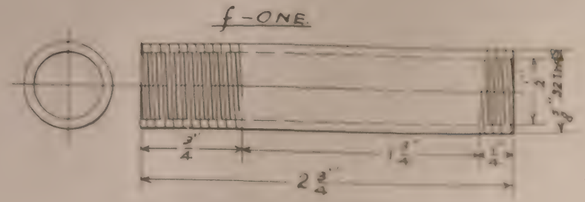


NUMBER A SET	A
2	1¼"
2	1"
2	¾"

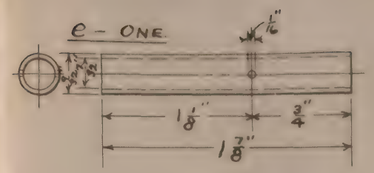
DETAILS
RECORDING APPARATUS.
FOR
TORSION TESTS.

F.B. CAST IRON. JUNE, 1904.

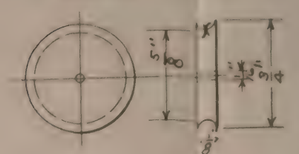
f - ONE.



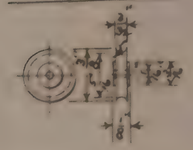
e - ONE.



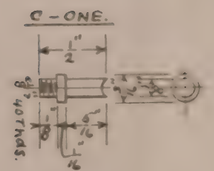
C, C, E, E, - FOUR.



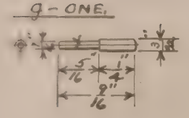
D, D, TWO.



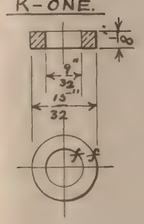
c - ONE.



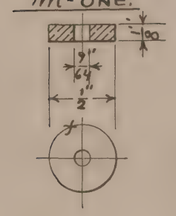
g - ONE.



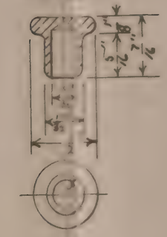
K - ONE.



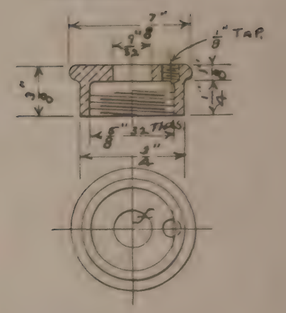
m - ONE.



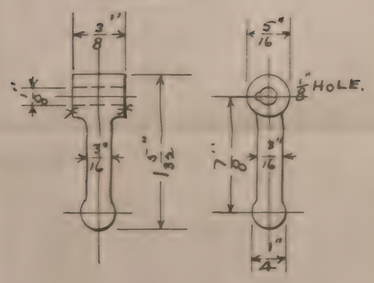
d - ONE.



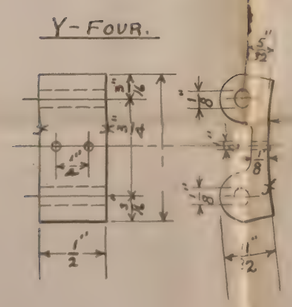
b - ONE.



V - TWO.

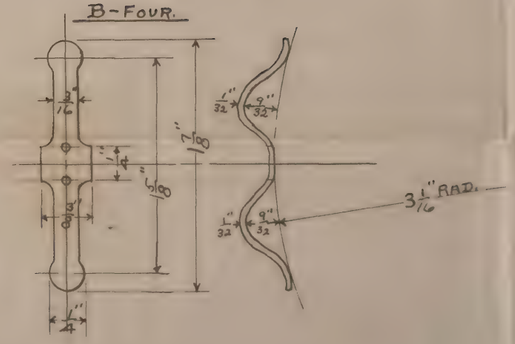


Y - FOUR.



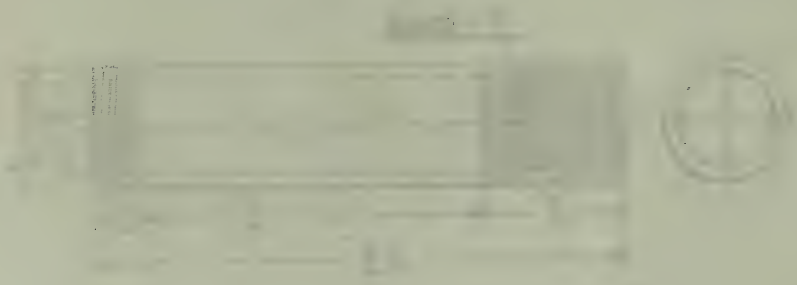
3 1/16" RAD.

B - FOUR.

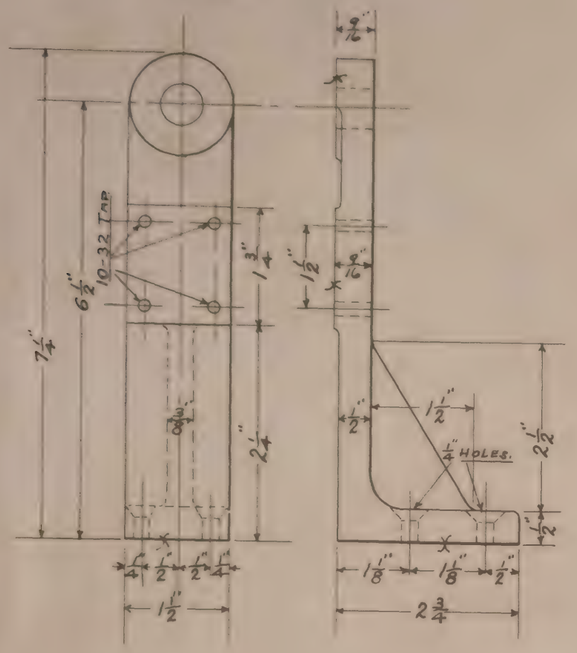


DETAILS.
RECORDING APPARATUS.
FOR
TORSION TESTS.

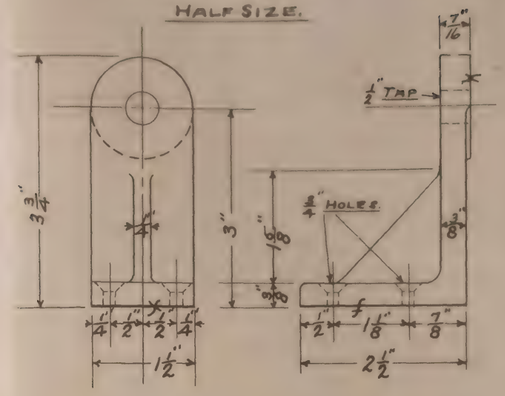
F.B. FULL SIZE. BRASS. JUNE, 1904.



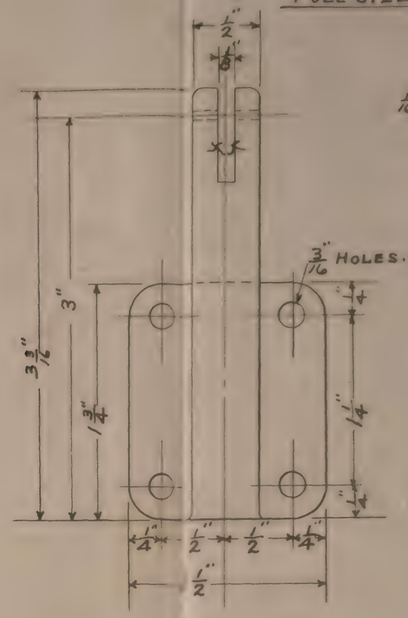
r, r - TWO.
HALF SIZE.



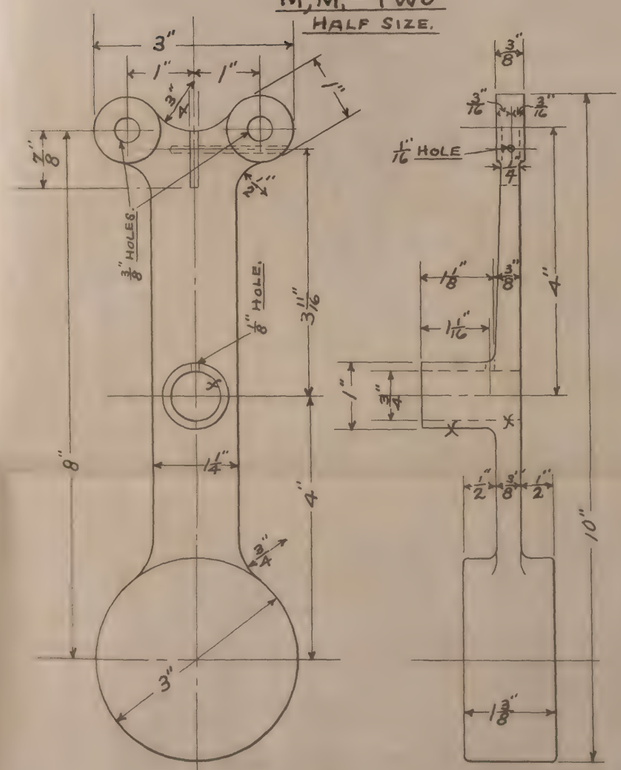
w, w, - TWO.
HALF SIZE.



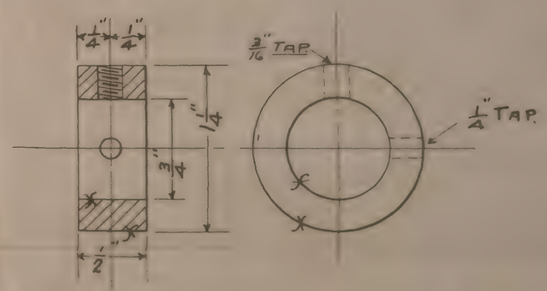
t, t, - TWO.
FULL SIZE.



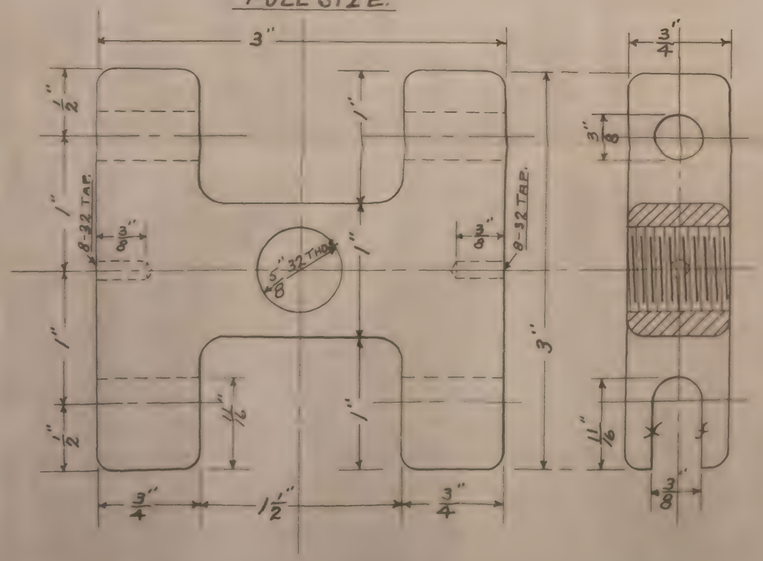
M, M, - TWO
HALF SIZE.



i, i, - TWO.
FULL SIZE.

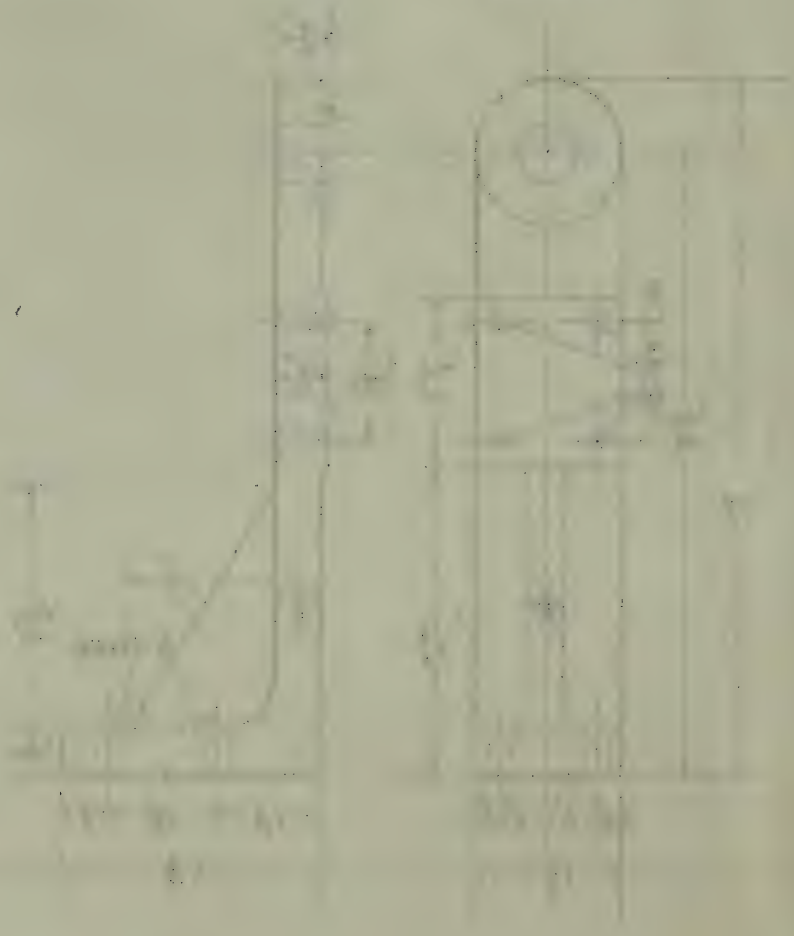


S - ONE.
FULL SIZE.

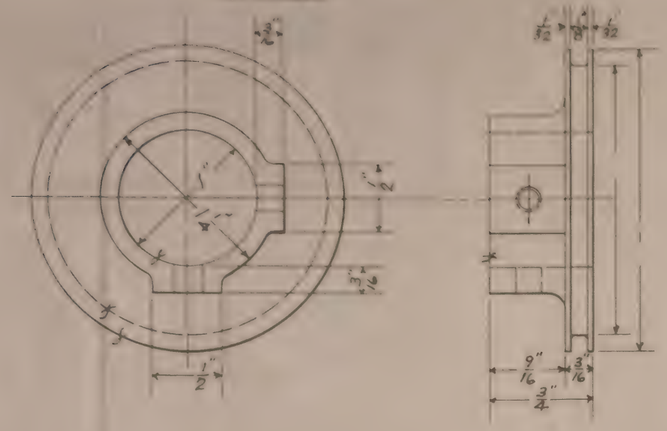


DETAILS.
RECORDING APPARATUS.
FOR
TORSION TESTS.

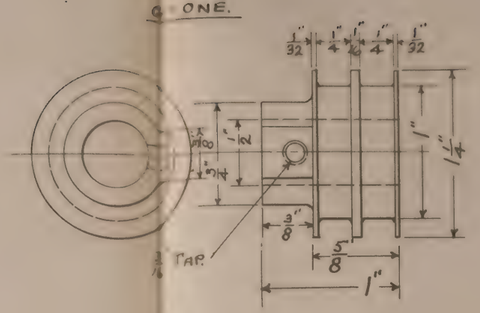
F.B. CAST IRON. JUNE, 1904.



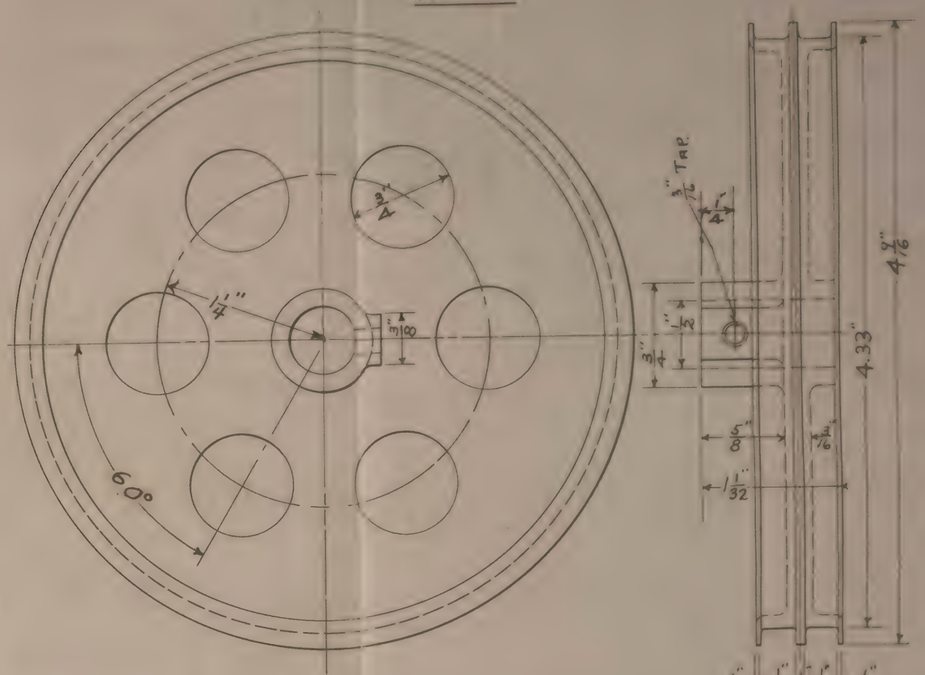
Q, - ONE.



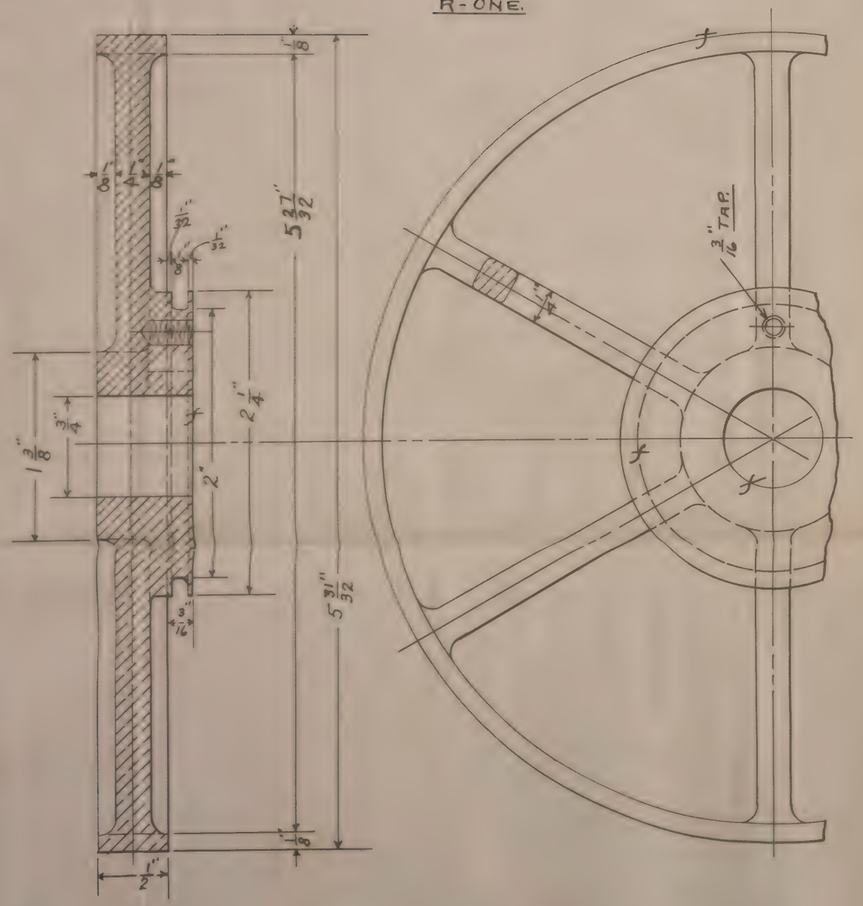
G - ONE.



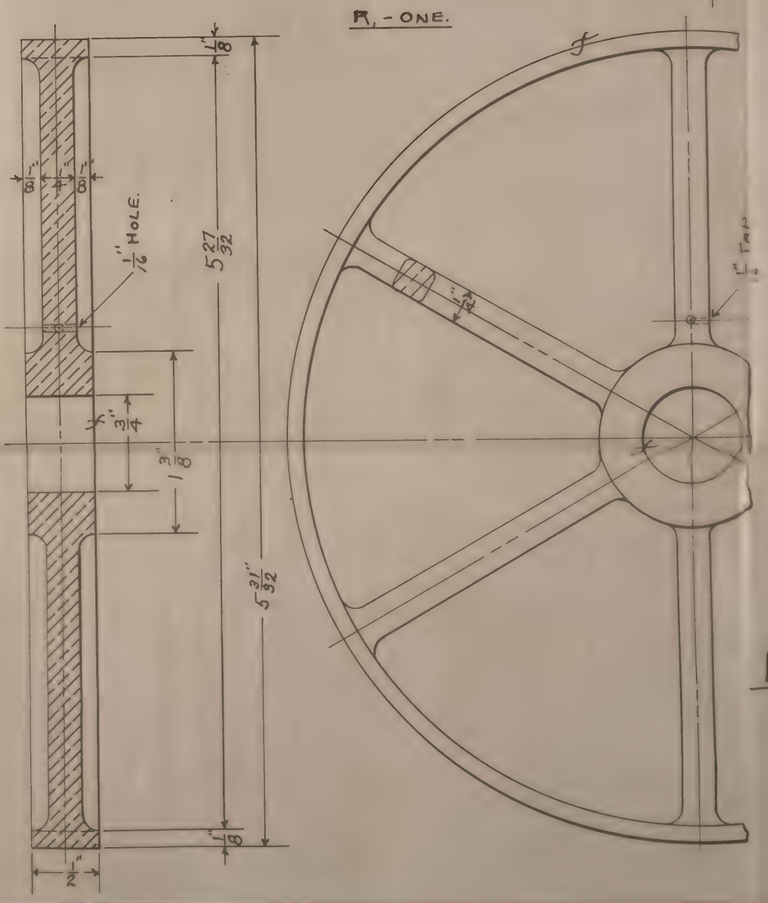
H - ONE.



R - ONE.



R, - ONE.



DETAILS.

RECORDING APPARATUS.

FOR

TORSION TESTS.

F.B. BRASS JUNE, 1904.

FULL SIZE.